

CLAIMS

4-11-61
1. A liquid crystal display apparatus comprising a light conductor plate and a light source arranged on a side surface of said light conductor plate, thereby lightening a liquid crystal cell from a side of a back surface, wherein the light conductor plate has an incident surface for a light from the light source, a light emitting surface for emitting the input light to the liquid crystal cell, and a plurality of dots constituting by small projecting portions or small recess portions for changing a moving direction of the light from the incident surface toward a direction of the light emitting surface.

2. A liquid crystal display apparatus comprising a light conductor plate and a light source arranged on a side surface of said light conductor plate, thereby lightening a liquid crystal cell from a side of a back surface, wherein the light conductor plate has an incident surface for a light from the light source, a light emitting surface for emitting the input light to the liquid crystal cell, and a plurality of dots constituting by small projecting portions or small recess portions for changing a moving direction of the light from the incident surface toward a direction of the light emitting surface provided on a surface opposite to the light emitting surface.

3. A liquid crystal display apparatus comprising a light conductor plate and a light source arranged on a side surface of said light conductor plate, thereby

lightening a liquid crystal cell from a side of a back surface, wherein the light conductor plate has an incident surface for a light from the light source, a light emitting surface for emitting the input light to the liquid crystal cell, and a plurality of dots constituting by small projecting portions or small recess portions for changing a moving direction of the light from the incident surface toward a direction of the light emitting surface provided on the light emitting surface.

4. A liquid crystal display apparatus as claimed in any one of claims 1 to 3, wherein an area of each of said dots constituting by the small projecting portions or the small recess portions is within a range between 0.2 and 0.000025 square mm.

5. A liquid crystal display apparatus as claimed in any one of claims 1 to 3, wherein an area of each of said dots constituting by the small projecting portions or the small recess portions is within a range between 0.01 and 0.0001 square mm.

6. A liquid crystal display apparatus as claimed in any one of claims 1 to 5, wherein a shape of each of said dots constituting by the small projecting portions or the small recess portions is a substantially rectangular shape, and a length of a short line thereof is equal to or less than 200 μ m.

7. A liquid crystal display apparatus as claimed in any one of claims 1 to 5, wherein a shape of each of said dots constituting by the small projecting portions

or the small recess portions is a substantially rectangular shape, and a length of a short line thereof is between 10 and 100 μm .

8. A liquid crystal display apparatus as claimed in any one of claims 1 to 7, wherein a shape of each of said dots constituting by the small projecting portions or the small recess portions is a substantially rectangular shape, and a ratio between a short line and a long line thereof is equal to or less than 80.

9. A liquid crystal display apparatus as claimed in any one of claims 1 to 7, wherein a shape of each of said dots constituting by the small projecting portions or the small recess portions is a substantially rectangular shape, and a ratio between a short line and a long line thereof is equal to or less than 20.

10. A liquid crystal display apparatus as claimed in any one of claims 1 to 9, wherein a height or a depth of each of said dots constituting by the small projecting portions or the small recess portions is within a range between 2 and 100 μm .

11. A liquid crystal display apparatus as claimed in any one of claims 1 to 9, wherein a height or a depth of each of said dots constituting by the small projecting portions or the small recess portions is within a range between 5 and 40 μm .

12. A liquid crystal display apparatus as claimed in any one of claims 1 to 11, wherein a shape of each of said dots constituting by the small projecting portions

or the small recess portions is a substantially rectangular shape, and a long line of the rectangular shape is arranged substantially in parallel to the light emitting surface of the light source.

13. A liquid crystal display apparatus as claimed in any one of claims 1 to 12, wherein an angle of incline of a cross section of each of said dots constituting by the small projecting portions or the small recess portions is within a range between 7 and 85 degrees.

14. A liquid crystal display apparatus as claimed in any one of claims 1 to 12, wherein an angle of incline of a cross section of each of said dots constituting by the small projecting portions or the small recess portions is within a range between 7 and 43 degrees.

15. A liquid crystal display apparatus as claimed in any one of claims 1 to 14, wherein a number per a unit area of the small projecting portions or the small recess portions in said light conductor plate is increased from a side of the light source toward an opposite side.

16. A liquid crystal display apparatus as claimed in any one of claims 1 to 15, wherein a reflecting film is formed on a surface forming the dots constituting by the small projecting portions or the small recess portions in said light conductor plate.

17. A liquid crystal display apparatus as claimed in any one of claims 1 to 16, wherein the small projecting portions or the small recess portions in said light conductor plate are arranged at random.

18. A liquid crystal display apparatus as claimed in any one of claims 1 to 17, wherein an angle of incline in cross section of the dots constituting by the small projecting portions or the small recess portions in said light conductor plate is changed from a portion near the light source toward a portion apart from the light source, and an angle thereof is substantially smaller at the portion near the light source.

19. A liquid crystal display apparatus as claimed in any one of claims 1 to 18, wherein an angle of incline in cross section of the dots constituting by the small projecting portions or the small recess portions in said light conductor plate is changed from a portion near the light source toward a portion apart from the light source, an angle thereof is substantially smaller at the portion near the light source, and when sectioning the dot forming surface of the light conductor plate by a regular square of 1 to 4 square cm, an average of an angle of incline of a cross section within a regular square closest to the light source is 0.5 to 15 degrees different from an average of an angle of incline of a cross section within a regular square most apart from the light source.

20. A liquid crystal display apparatus as claimed in any one of claims 1 to 17, wherein when sectioning the dot forming surface of said light conductor plate by a regular square of 1 to 4 square cm, an angle of incline of a cross section of the dots constituted by the small projecting portions or the small recess portions existing

within said regular square is changed at every dots or every dot portions within one dot.

21. A liquid crystal display apparatus as claimed in any one of claims 1 to 17, wherein when sectioning the dot forming surface of said light conductor plate by a regular square of 1 to 4 square cm, an angle of incline of a cross section of the dots constituted by the small projecting portions or the small recess portions existing within said regular square is changed at every dots or every dot portions within one dot, within a range between averages ± 2 and 15 degrees within said regular square.

22. A liquid crystal display apparatus as claimed in any one of claims 1 to 21, wherein a width of the dots constituted by the small projecting portions or the small recess portions in said light conductor plate, that is, a length of the dots in a direction perpendicular to the light source is changed from a portion near the light source toward a portion apart from the light source, and the width is substantially great in the portion near the light source.

23. A liquid crystal display apparatus as claimed in any one of claims 1 to 22, wherein an average distance between the dots constituted by the small projecting portions or the small recess portions in said light conductor plate, that is, a square root of a result obtained by a formula unit distance \div dot density is changed from a portion near the light source toward a portion apart from the light source, and the distance is

substantially great in the portion near the light source.

24. A liquid crystal display apparatus as claimed in any one of claims 1 to 23, wherein a calculated average surface roughness R_a of portions other than a dot forming surface of the dots constituted by the small projecting portions or the small recess portions in said light conductor plate is set to be equal to or less than $0.3 \mu\text{m}$.

25. A liquid crystal display apparatus as claimed in any one of claims 1 to 23, wherein a calculated average surface roughness R_a of portions other than a dot forming surface of the dots constituted by the small projecting portions or the small recess portions in said light conductor plate is set to be equal to or less than $0.05 \mu\text{m}$.

26. A liquid crystal display apparatus as claimed in any one of claims 1 to 25, wherein a prism sheet having a relation of $90 < \theta_{p1} < 60$ degrees and $26 < \theta_{p2} < 55$ degrees is used in combination with said light conductor plate.

27. A liquid crystal display apparatus as claimed in any one of claims 1 to 26, wherein a thickness of said light conductor plate is different in accordance with a distance from the light source.

28. A method of manufacturing a light conductor plate for a liquid crystal display apparatus comprising:

- (1) a step of forming a photo resist on a stamper original plate;

- (2) a step of arranging a photo mask having a flat surface shape pattern or an inverted pattern of a dot constituted by a small projecting portion or a small recess portion on a base plate and developing after irradiating an ultraviolet ray from an upper portion of a mask so as to form a pattern for forming the small projecting portion or the small recess portion on the stamper original plate;
- (3) a step of making said pattern in a mask and etching the stamper original plate so as to form a plastic forming metal stamper;
- (4) a step of plastic molding with using said stamper.

29. A method of manufacturing a light conductor plate for a liquid crystal display apparatus comprising:

- (1) a step of forming a photo resist film on a base plate;
- (2) a step of arranging a photo mask having a flat surface shape pattern or an inverted pattern of a dot constituted by a small projecting portion or a small recess portion on said base plate and developing after irradiating an ultraviolet ray from an upper portion of a mask so as to form a pattern for forming the small projecting portion or the small recess portion on the stamper original plate;

- (3) a step of dry etching said pattern so as to form a pattern;
- (4) a step of applying a metal plating so as to form a plastic forming stamper;
- (5) a step of plastic molding with using said stamper.

30. A method of manufacturing a light conductor plate for a liquid crystal display apparatus comprising:

- (1) a step of forming a photo resist film on a base plate;
- (2) a step of arranging a photo mask having a flat surface shape pattern or an inverted pattern of a dot constituted by a small projecting portion or a small recess portion on said base plate and developing after irradiating an ultraviolet ray from an upper portion of a mask so as to form a pattern of the dot constituted by the small projecting portion or the small recess portion on the stamper original plate;
- (3) a step of applying a metal plating on said pattern so as to form a plastic forming metal stamper;
- (4) a step of plastic molding with using said stamper.

31. A method of manufacturing a light conductor plate for a liquid crystal display apparatus comprising:

- (1) a step of forming a photo resist film on a base plate;

- (2) a step of arranging a photo mask having a flat surface shape pattern or an inverted pattern of a dot constituted by a small projecting portion or a small recess portion on said base plate and developing after irradiating an ultraviolet ray from an upper portion of a mask so as to form a pattern of the dot constituted by the small projecting portion or the small recess portion on the stamper original plate;
 - (3) a step of heating said pattern to a temperature between 155 and 200 degrees so as to set an angle of incline of a cross section of the resist to a predetermined angle between 7 and 85 degrees with respect to a base plate surface;
 - (4) a step of applying a metal plating on said pattern so as to form a plastic forming metal stamper;
 - (5) a step of plastic molding with using said stamper.
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